(511) III/285

1) Report on the operation for the Kharif season conducted at the Experimental Farm, Cawnpore 1881

2) Report on the Cawnpore Experimental Farm for the ~~Season~~ Kharif Season, 1880

III

Report on the operation for the Kharif season
Conducted at the Experimental Farm, Cawnpore, 1880,

No. $\frac{622A.}{XXXVI.}$ OF 1881.

FROM

THE OFFG. DIRECTOR, DEPT. OF AGRI. AND COM.,

NORTH-WESTERN PROVINCES AND OUDH,

TO

THE SECRETARY TO GOVERNMENT,

NORTH-WESTERN PROVINCES AND OUDH.

DATED CAWNPORE, THE 29TH MARCH, 1881.

SIR,

I HAVE the honor to submit the report on the operations for the *kharif* season of 1880, conducted at the Experimental Farm, Cawnpore, by Mr. Fuller, Assistant Director, Department of Agriculture and Commerce, (in charge).

Deep ploughing

2. The success of the experiments was, to as certain degree, marred by the unpropitious character of the season; but, as a set-off to this disadvantage, conclusive proof was obtained, if any were still required, of the benefit resulting from deep cultivation in a season of drought.

3. Those plants naturally benefit most which are deep feeders, and by means of a tap root utilise a larger food-supply if made available by a deep stirring of the soil. Thus cotton benefited in a remarkable degree by deep cultivation, both with or without inversion of the soil, and similar results were obtained in the Rawatpur estates managed by Mr. Harrison, Assistant Collector, on which a report has been previously submitted. On the other hand, surface feeders, as the millets and other cereals, derive but little benefit the first year from deep cultivation, or even suffer from the rawness of the newly-inverted soil.

4. But the experiments conducted by Mr. Fuller with *sorgho* show that, for shallow feeding plants also, deep ploughing may be beneficial, if the freshly brought up soil *has had time to mature*, and with this object the land should be ploughed early in May immediately after the rabi harvest. The hot winds and sun during May and June have the effect of fertilising the soil exposed to their influence.

5. Managers of estates under the Court of Wards have been advised to experiment in this direction, and the Public Works Department (Irrigation Branch) has granted the concession of free irrigation for sufficient land for experiment during the period when canal water is not in general demand. The experiment has not however, through some misunderstanding, been given a thorough trial.

6. Mr Fuller's experiments with both cotton and jowar bring out very clearly that the indigenous staples of the country are, (as I have always held) by careful selection and proper cultivation, capable of holding their own against imported varieties. In the case of cotton similar results were obtained in the Rawatpur estate (Rawatpur is within three miles of the experimental farm), and I have frequently had occasion to give it as my opinion that except for its saccharine properties, the *Sorghum Saccharatum* is in no way superior to the jowar (*Holcus Sorghum* or *sorghum*) of the country. The ordinary cultivator will prefer the latter, as giving him a food as well as a fodder crop, and unless *sorghum* is grown for sugar any heavier weight of fodder it may give will only recommend it to owners of cattle farms.

Fodder crops.

7. The fodder question is so important, inasmuch as we cannot hope to permanently improve the breed of agricultural cattle if there is not sufficient food in the

country to keep larger beasts in good condition, that Mr. Fuller's experiments on the relative *dry weight* of the several fodder plants possess much interest. Here, again, jowar comes out best, and reana (*euchlæna luxurians*) worst. I have, for some time past, discontinued recommending the cultivation of this highly-vaunted fodder plant, chiefly on the ground of its requiring very high (almost garden) cultivation, and not promising well for a field crop. I am glad to find my unfavorable opinion of it corroborated by additional evidence as to its unfitness for the North-Western Provinces.

Cotton.

8. Mr. Fuller's experiments on the several varieties of cotton give valuable results, indicating the relative productiveness of the varieties of cotton grown. The indigenous Kulpahar variety gave the largest, the Bamieh the smallest outturn. I have never advocated the cultivation of the Bamieh cotton, though it is superior in staple to all American cottons and, *fortiorid*, to native varieties. This very high quality is against it, the mills have not the proper machinery to work so fine a staple, and it will not pay them to get out machinery to manufacture a class of goods in which home competition would give them but a poor chance of success. The difficulty, moreover, in cultivating the Bamieh variety and its poor outturn, as shown by Mr. Fuller's experiments, are fatal to its general cultivation.

9. The reasons given by Mr. Fuller for the greater success of the indigenous varieties of cotton compared with the imported varieties, such as New Orleans, and Upland Georgian, appear sound. The former unquestionably grows best, and is indeed almost entirely cultivated in the drier tracts of these provinces, the Agra and Allahabad Divisions. The American cotton, being grown under moister atmospheric conditions, will doubtless find a more congenial climate in the eastern districts, and endeavours will be made to secure a thorough and careful trial being there made of them.

Maize.

10. Maize, as a cold weather crop, has done well both in the farm and at Rawatpur. I question, however, whether it will oust the cereals generally grown at that season in these provinces. As a rent-paying crop, wheat will pay the cultivator better; as a food-crop, he has his mixed barley crops, or lives on the millets which he has stored from his autumn harvest.

Winnowers.

11. The success of Mr. Fuller's experiment in adopting the more scientific agricultural implements of the west to the wants of the Indian cultivator, has obtained substantial proof by the large orders given for them at the Lucknow Agricultural Exhibition. Mr. Fuller speaks of the light swing plough, but it has for some time past been my opinion that the ryot is not yet ready for a swing plough, the adjustment of which is difficult and distasteful to him. It is necessary to concede to his prejudice as much as we can without abandoning the principle for which we are contending, *i. e.*, deep cultivation and inversion of the soil. If the cultivator will not take our ploughs without a beam, it is better to yield on that point rather than that he should not take them at all. I was confirmed in this opinion by the representations of some of our correspondents. I requested Mr. Fuller to make up a Kaisar plough with beam; he did so, and it was exhibited at Lucknow, where it received the first prize.

12. Another question which calls for careful consideration is that of determining the exact point where economy ceases to be compatible with efficiency. A cheap is very unlikely to be a lasting article, and there is always the fear that in our endeavour to bring a certain implement within the reach of the poorer cultivator, we may sacrifice its efficiency and imperil its success with that class of cultivators which can and would rather pay more for a better article, while the price is still beyond the resources of the million. This is particularly the case with the winnowers; they are cheap and efficient, but will they last? A much better article has been made up for the Rawatpur estate, costing about Rs. 40; and I have recommended a better wood being used than mango, which is apt to warp, and greater finish in detail.

13. Mr. Fuller has made no mention of the Kewani windmill which, at the suggestion of Mr. Bernard (then Home Secretary to the Government of India), has recently been imported from America. It has been put up over a canal channel, but, though an excellent article of its kind, seems ill-adapted for this country, where the wind-power is so variable and often altogether wanting at the very season when irrigation is most required. Mr. Fuller will experiment further on the uses to which a windmill may be applied, and note the remark in future reports.

I have the honor to be,

SIR,

Your most obedient servant,

F. N. WRIGHT,

Offg. Dir. of Agriculture and Commerce, N.-W. P. and Oudh.

REPORT

ON THE

CAWNPORE EXPERIMENTAL FARM,

FOR THE

Kharif Season, 1880.

THE operations conducted on the farm during the season under report include (1) a series of field experiments to determine the value of certain agricultural processes, seeds, and manures; and (2) the development and manufacture of cheap agricultural implements in the farm workshops.

I.—FIELD EXPERIMENTS.

I.—FIELD EXPERIMENTS.

Effect of failure of the autumn rains.

2. The failure of the autumn rains greatly interfered with the success of the experiments, especially in the case of those conducted to test the value of manures. The rainfall, as measured on the farm between 1st June and 30th November, 1880, only amounted to 6·06 inches (the normal for that period being about 27·6 inches), and was actually less by 3·67 inches than the rainfall during the corresponding month of 1877, the year of scarcity. It is certain, however, that the season under report was less disastrous than that of 1877, and the reason for this must lie in the different distribution of the rainfall in the two seasons. This difference is indicated in the subjoined table :—

Autumn rainfall of 1877 contrasted with that of season under report.

	Rainfall (in inches).		Number of days on which rain fell.	
	1877.	1880.	1877.	1880.
June	0·4	0·1	2	1
July	1·6	3·52	2	14
August	3·4	0·91	5	9
September	0·9	1·45	2	5
October	3·4	0·05	3	2
November	0·0	0·03	0	1
Total ...	9·7	6·06	14	32

If we exclude the rain which fell in October, 1877, and which was of little service to the kharif crops, the total rainfall of both seasons is almost exactly the same. As regards its *distribution*, however, the season under report differs broadly from the corresponding period of 1877, firstly, in that the rainfall was spread over more than double the number of days, and secondly, in that the month of maximum rainfall was July instead of August, and the young plants received a start which enabled them to withstand, in some measure, the drought of subsequent months instead of, as in 1877, being starved at the very commencement of their growth.

Failure of most of the experiments with manures.

3. A large number of the experimental fields were irrigated from the Ganges Canal, and fair crops gathered in consequence. But irrigation could not in many cases be given at the time it was required, since the Farm lands depend for their water supply on the tail of a distributary, and received it very irregularly. Maize suffered most conspicuously, and unfortunately this was the crop with which most of the experiments on manures were made. The manures experimented with were unable to produce their full effect in the absence of sufficient water, and the results which were obtained must be held unreliable. I regret also to state that the results of two series

of manure experiments were still further vitiated, the one by the produce of different plots having been mixed through the carelessness of some of my subordinates, and the other in consequence of the plots not being on a par as regards their treatment in previous years, which, while shown in the farm records to have been similar, was in reality very far from being so.

The benefits resulting from deep cultivation brought out into stronger prominence by the failure of rain

4. But the failure of rain was not without service in another direction, since it brought out into extraordinary prominence the great benefit which results from a deeper cultivation of the soil than that generally in vogue. Experiments to test the value of deep cultivation, with and without inversion of the soil, were tried with representatives of deep feeding and shallow feeding crops, *i e.*, those which penetrate deeply into the ground by a tap root (*e. g.*, cotton and the pulses) and those which feed nearer the surface by a "crown" of fibrous rootlets (*e. g* , maize, millets, and all other cereal grasses). The results have shown that it is the former class of crops which benefit most strikingly by an increase in the depth of their seed bed, while in the case of the latter class of crops the disadvantage resulting from the rawness of the fresh soil brought to the surface may at the outset more than counterbalance the advantage they derive from the greater depth of tilth. This accounts for the numerous instances reported from Court of Wards estates and elsewhere in which the use of the English plough actually diminished the outturn, since the experiment was invariably made with a cereal and the results were judged from the crop gathered in the first season after the ploughing, before the newly turned soil had had time to mature. The results of the experiments of the season under report appear to leave no doubt that tap-rooted plants derive an immediate and striking benefit from a deeper seed bed than that which is generally prepared for them. Details of these results are given in para. 8 of this report, but it may be noted here that in one case cultivation with the English plough gave, *on unirrigated land*, an outturn of 360 lbs. of cleaned cotton to the acre, while the ordinary cultivation of the country only yielded 150 lbs., which was, if anything, above the average outturn for the unirrigated cultivated fields in the neighbourhood of the farm. *The use of the English plough therefore increased the value of outturn by Rs. 43 per acre.*

but is more marked in the case of "deep-feeding" plants than in the case of cereals.

List of the field experiments conducted.

5. During the season under report experiments were conducted to test—

(1) the effect of different manures.

(2) the effect of deep cultivation, with and without inversion of the soil.

(3) different kinds of fodder crops.

(4) different kinds of cotton.

(5) different kinds of maize.

(i.) Experiments on the effect of different manures

All the experiments but one were prejudiced by the failure of rain or other causes, and their results are therefore of no value.

6. (i) **Experiments on the effect of different manures.**—With one exception the crop with which all the experiments were made was maize, and it suffered so greatly from deficiency of water that the results which were obtained are valueless. The outturns were not only extremely small, but discordant, since the different manures had no fair chance of producing their full effect. In the case of one series of experiments it is evident that I was misled by the Farm records in believing the series of plots experimented with to have been on a par as regards previous cropping and manuring. I have alluded in a previous report to the hopeless inaccuracy of these records, and I should not have trusted to them in the present case had not the ground from which the plots were demarcated lain fallow during the preceding year, so that I had had no opportunity of judging of its quality by seeing it cropped. The only experiment the results of which I consider may be relied on is one which was tried with rice, the manure experimented on being bone dust, *i.e.*, bones ground fine but not treated with acid. The field lay immediately under the canal distributary and received numerous floodings, but the supply of canal water was irregular and the crops were watered at irregular intervals, the ground twice completely drying up. The field was ridged with the light "Kaisar" plough by turning each furrow slice *against* the one preceding it, instead of *with* it, as in ordinary ploughing. It was then divided off into two equal

An experiment with bone dust on rice succeeded, because there were good facilities for irrigation.

Details of the experiment.

plots, one being manured with bone-dust strewn along the furrows, at the rate of 5¼ maunds to the acre, and the other being left unmanured. The rice was sown in the furrows, on the South Carolina system, at the rate of 90 lbs. to the acre. It was of the fine variety known as *Jhilma*, some of which was kindly given me by Pandit Ajudhiya Parshad, Talúqdar of Indalpur, in the Sháhjahánpur district. The result is shown below:—

Area of plot in square yards.	Manure and rate per acre.	Seed and rate per acre.	Weeding.	Outturn in lbs.				† Value of outturn per acre.	Cost of cultivation per acre.
				Actual.		*Per acre.*			
				Grain (unhusked).	Straw.	Grain (unhusked).	Straw.		
								Rs. a. p.	Rs. a. p.
112·7*	Bone dust @ 5 maunds 25 seers.	Jhilma rice @ 90 lbs.	Once ...	30·75	64	1,320·5	2,748·5	51 10 2	25 3 0
112·7	*Nil* ...	Ditto ...	Ditto,	24·75	50	1,062·9	214,7·2	40 14 7	21 3 0

The bone dust was ground in a lever mill (*dhekoli*) worked by coolies and cost 12 annas a maund. Its use to the value of Rs. 4 per acre increased the outturn of grain 24 per cent. and of straw 28 per cent., and gave a clear additional profit of Rs. 10 per acre.

7. In the experiments which were conducted last rabi season to test the value of bones as manure, the bones were applied in the form of superphosphate of lime, *i.e.*, after having been treated with sulphuric acid. This greatly increased the solubility of the manure, and, consequently, its *immediate* efficacy. But it also enormously added to its cost, a maund prepared in this way costing Rs. 3-9-3. Bone dust untreated with acid only costs 12 annas a maund, and it is therefore only in the form of bone dust that the use of bones as manure could become general with the Indian cultivator. As a rule, its full effect must not be looked for till the second year after its application, since under ordinary circumstances it requires time to become soluble, but the present experiment shows that, when applied to rice *in conjunction with copious irrigation*, excellent results may be obtained in the first year.

This is the first experiment made with *bone dust*, preceding ones having been made with *bone superphosphate*.

8. **(ii) Deep cultivation with and without inversion of the soil**—was tried against the ordinary native method in two series of experiments. In the first series the crop experimented with was Sorgho or Impee (*Sorghum saccharatum*) a shallow-feeding fodder crop of the millet order; in the second series the crop was cotton, which is well known to be a deep feeder, driving its tap root far down into the soil. But in addition to the results of these two series of experiments, we have the outturns obtained from a number of other farm fields deep ploughed but not manured or irrigated, which may fairly be contrasted with the crops gathered on the unmanured and unirrigated cultivators' fields in the neighbourhood.

(ii) Deep cultivation.

Two series of experiments, each series consisting of four plots.

Results of these experiments borne out by the outturns of other miscellaneous farm fields.

First series, Sorgho.—A field hired from a cultivator and previously untouched by any other sort of plough than the native one was divided into four plots, each containing 400 square yards:—

First series. Sorgho. Treatment of the four plots constituting the series.

Plot 1—Was ploughed (*i. e.*, the soil inverted) to a depth of six inches immediately before being sown.

Plot 2—Was also ploughed to a depth of six inches, but two months before being sown (*i. e.*, in the May preceding) so that the soil newly brought to the surface had some little time to mature.

* The area of each plot, as originally marked out, was double this, but it was necessary to exclude at least half of the unmanured plot since it lay rather higher than the rest and received less water. The area of the manured plot was therefore also reduced in proportion.

† The high value of the outturn is due to the high price of straw which owing to the scarcity of fodder was almost as valuable as the grain.

Plot 3—Was grubbed to a depth of six inches, but the soil not inverted, immediately before being sown.

Plot 4—Was treated in the manner ordinarily adopted by native cultivators, *i. e.*, twice grubbed with the native plough immediately before being sown.

Results of the experiment.

The sorgho was sown broadcast on all four plots and ploughed in with the native plough. Subsequently, when a failure of rain seemed imminent, each plot was divided into two equal portions, one portion being watered twice, while the other was only watered once.

The results are shown below:—

Area of plot in square yards.	Treatment on account of crop experimented with.				Previous treatment.			Outturn of green fodder.		Cost of cultivation per acre.	Value of produce per acre.
	Ploughing.	Manured rate per acre.	Irrigation.	Weeding.	Year.	Manure and rate per acre.	Crop.	Actual.	Per acre.		
	Half plots irrigated once.							Md. s.	Md s.	Rs.a.p.	Rs a.p.
200	Soil inverted to 6″ immediately before sowing.	*Nil.*	Once, September 10th.	Once, August 1st.	1879-80,	*Nil* ...	Juar ...	2 20	60 20	14 3 0	20 2 8
200	Ditto, but in May preceding.	*Nil.*	Ditto ...	Ditto ...	1879-80,	Dung at 120 maunds.	Wheat,	5 5	124 1	14 3 0	41 5 5
200	Grubbed to 6″ (soil not inverted) immediately before sowing.	*Nil.*	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto...	5 0	121 0	14 3 0	40 5 4
200	Country ploughed twice.	*Nil.*	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto...	3 0	72 24	14 3 0	24 3 2
	Half plots irrigated twice.										
200	Soil inverted to 6″ immediately before sowing.	*Nil.*	Twice, August 22nd and September 10th.	Once, August 1st.	1879-80,	*Nil* ...	Juar ...	3 5	75 25	14 5 0	25 3 4
200	Ditto, but in May preceding.	*Nil.*	Ditto ...	Ditto ...	1879-80,	Dung at 120 maunds.	Ditto ...	7 20	181 20	14 5 0	60 8 0
200	Grubbed to 6″ (soil not inverted) immediately before sowing.	*Nil.*	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	7 30	187 22	14 5 0	62 8 3
200	Country ploughed twice.	*Nil.*	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto...	3 30	90 10	14 5 0	30 1 4

Taking therefore the outturns of the country ploughed plots as standards of comparison, we find that—

Inversion of the soil for a depth of six inches, two months before sowing, increased the outturn by 72 per cent. when once irrigated, and by 100 per cent. when twice irrigated. *Grubbing to a depth of six inches, without inversion*, increased the outturn by 68 per cent. when once irrigated, and by 107 per cent. when twice irrigated; while *inversion of the soil to a depth of six inches, immediately before sowing*, diminished the outturn by 16 per cent. when once irrigated, and by 16 per cent. when twice irrigated.

Part of the great difference between the outturn of the early and late ploughed plots may be due to differences in their previous treatment.

I believe, however, that these figures exaggerate the difference in outturn which results from inversion of the soil immediately before sowing, and inversion of the soil two months previous. It will be noticed that while the previous treatment of the two last plots was exactly similar, that of the first plot was somewhat different, an unmanured crop of juar having been reaped in the preceding *khartf* instead of (as in the other three plots) a manured crop of wheat in the preceding *rabi*. Still, under ordinary circumstances, a *khartf* crop following immediately on a lightly manured *rabi* crop (as was the case in plots 2, 3 and 4) would have but little advantage on a *khartf* crop following a *rabi* fallow (as was the case in plot 1), and this difference in the previous

treatment of the two English ploughed plots cannot be held to account altogether for the great difference between their outturn. A considerable portion of this difference must be due to the interposition of a two months' fallow between ploughing and sowing in the case of one plot, while there was no such fallow in the case of the other. The result may be taken to prove that for shallow feeding plants deep ploughing (*i. e.*, inversion of the soil) may in some cases be beneficial only when the freshly brought up soil has had time to mature. But, while keeping this in mind, due regard must be paid to the fact that the outturns of plots 2, 3 and 4, *which were on a par with one another in every way*, show that a deeper cultivation than that ordinarily given may increase the value of a crop of sorgho by as much as Rs. 30 an acre.

Second series. Cotton. Treatment of the four plots of the series.

9. *Series* 2. *Cotton.*—This series consisted, like the first, of four plots forming portions of a field which had been hired from a cultivator, and all *exactly alike* as regards soil and previous treatment. The same course was followed as in the first series, plot 1 being deep ploughed and the soil inverted to a depth of six inches immediately before sowing; plot 2 being treated in the same way, but two months before sowing, instead of immediately before; plot 3, grubbed to a depth of six inches without inverting the soil; and plot 4, twice ploughed with the country plough—the same treatment as cotton fields ordinarily receive. The seed which was sown was obtained from Kulpahar in Bundelkhand, where a much better variety is cultivated than in the districts of the Ganges-Jumna Doáb.

It was expected that cotton, being a deeper feeding plant than sorgho, would derive more benefit from deeper cultivation. The results more than justify the expectation, and furnish what appears to be good proof of the vast benefit which may result from deep cultivation in a year of drought. The results are shown in the subjoined table. Each plot was sub-divided into two portions, one being irrigated twice, while the other received no irrigation whatever :—

Area of plot in square yards.	*Treatment on account of crop experimented with.*				*Previous treatment.*			*Outturn of clean cotton.*		* Cost of cultivation per acre.	Value of produce per acre.
	Ploughing.	Manure.	Irrigation.	Weeding.	Year.	Manure.	Crop.	Actual.	Per acre		
	Half plots unirrigated.							lbs.	lbs.	Rs. a. p.	Rs. a. p.
200	Soil inverted to 6″ immediately before sowing	Nil.	Nil.	Once,	1879-80	?	Juar ...	14·0	338·8	12 0 0	69 13 8
200	Ditto but two months before sowing.							15·0	363·0	12 0 0	74 13 6
200	Grubbed to 6″ (but soil not inverted) immediately before sowing.							8·1	196·5	12 0 0	40 8 2
200	Twice ploughed with country plough.							6·8	154·1	12 0 0	31 12 4
	Half plots twice irrigated.										
200	Soil inverted to 6″ immediately before sowing.	Nil.	Twice,	Once,	1879-80	?	Juar ...	16·3	394·4	14 8 0	81 5 1
200	Ditto but two months before sowing.							16·3	394·4	14 8 0	81 5 1
200	Grubbed to 6″ (but soil not inverted) immediately before sowing.							10·8	261·3	14 8 0	53 14 0
200	Twice ploughed with country plough.							9·3	225·0	14 8 0	46 6 3

* Exclusive of cost of picking and ginning.

Taking the country ploughed plots as standards of comparison, we find that deep cultivation gave the following percentages of increase :—

	Increase per cent.	
	On unirrigated plots.	On irrigated plots.
Inversion of the soil to 6″ two months before sowing ...	135	75
Ditto but immediately before sowing	119	75
Grubbing to 6″ without inverting the soil	27	16

These figures require but little comment. Taking first of all the unirrigated plots, we find that deep cultivation gives, in a season in which the rainfall was only $\frac{1}{6}$th of the normal, an outturn worth some Rs. 70 an acre, while the ordinary cultivation of the country could only yield Rs. 30. The condition of half plots 1 and 2 was a matter of surprise to all who saw them ; unirrigated as they were, the cotton plants stood thickly on them at an average height of $2\frac{1}{2}$ feet, while in plot 4 (which closely resembled the cultivators' unirrigated cotton fields in the neighbourhood) no plant stood much higher than 9 inches.

Outturns from other deep ploughed fields on the farm.

10. The crops gathered from other fields on the farm bear out the results yielded by the experimental plots. By the use of deep cultivation and inversion of the soil, crops of cotton, pulses, and oil seeds were raised without irrigation, while on the unirrigated cultivators' fields round the farm, under exactly the same conditions, the outturn of these crops was barely worth a rupee an acre. The actual outturn of these farm fields is shown below :—

Name of crop.	Area of field in square yards.	Treatment on account of crop experimented with.				Previous treatment.			Outturn in lbs.				Cost of cultivation. per acre.	Value of produce per acre.
									Actual.		Per acre.			
		Ploughing.	Manure.	Irrigation.	Weeding.	Year.	Manure and rate per acre.	Crop.	Grain.	Straw	Grain.	Straw.		
Pulses.													Rs. a. p.	Rs. a. p.
Moth (Phaseolus acontifolius).	390	English ploughed July 25.	*Nil*	*Nil*	Once, Aug. 20	1877-78	Sweeping 200 mds.	Wheat	67·75	117·25	840·79	1454·07	13 14 0	33 2 1
						1878-79	*Nil*	Barley						
						1879-80	*Nil*	Cotton						
Lobia (Dolichos sinensis).	415·2	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	17 75	57	206·91	664·45	13 14 0	10 3 9
Mung (Phaseolus Mungo).	447·7	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	22·5	75	260 71	869·04	14 0 0	14 13 9
Urid (Phaseolus radiatus).	504	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	15·5	82·5	148 84	792·26	13 14 0	10 7 10
Oilseeds,														
Til (Sesamum indicum).	452·2	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	57	138·5	610·08	1428·88	14 1 0	32 1 3
Tili (Sesamum indicum).	434·4	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	38	91·5	423·38	1019 47	14 3 0	24 14 0
Cotton.									*Cleaned cotton.*		*Cleaned cotton.*			
(Kulpahar variety).	4345·3	English ploughed July 20	*Nil*	*Nil*	*Nil*	1877-78	*Nil*	Barley	38·9		43·3		5 6 0	8 14 10
						1878-79	*Nil*	Gram.						
						1879-80	½ the field with Guano and ½ *Nil.*	Wheat						

Deep cultivation, therefore, if it did nothing else, at all events paid for the cost of cultivation, which must have been a dead loss to native cultivators under the same circumstances. In the case of *moth*, *til*, and *tili* a fair profit was gained. It is to be remarked that all of the above plants are tap rooted, and as a matter of fact deep cultivation was found of much smaller service in the case of maize and the millets grown during the season, which gave no crop worth the name without at least one watering.

(iii.) Different kinds of fodder crops.

11. (iii). **Different kinds of fodder crops.**—Careful comparative trial was made of the following rain fodder crops :—

The kinds of fodder which were tried.

Euchlœna (Reana) luxurians.
Juar (Holcus sorghum) the ordinary native fodder (*chari*).
Sorgho or Impee (Sorghum saccharatum) red seeded variety.
Ditto ditto black seeded variety.

All four crops were grown side by side in the same field, which was divided off into four equal portions for the purpose; all received the same amount of manure and were once irrigated.

An experimental cutting was also made of some Guinea grass (Panicum jumentorum) which had been planted out on well manured ground in April, 1879. The seedlings had been planted out at a distance of two feet apart, but had grown into huge tufts of tall grass closely resembling in appearance the common roadside grass known as *Patel* or *Sarpat* (Saccharum procerum). The crop had therefore occupied the ground for 15 months before it was cut, and its cost was higher than that of the other four fodder crops, in that the cost for three seasons must be debited against it instead of the cost for only one season. A previous cutting had been made off the same plants in March, 1880-81, so that the experimental cutting only included six months' growth.

Results of comparative trial.

All five crops were cut and weighed *green* on September 11, with the following results:—

Name of fodder.	Area of plot in square yards.	*Treatment on account of crop experimented with.*				*Previous treatment.*			*Outturn (in green fodder).*		Cost of cultivation per acre.	Value of produce per acre.
		Ploughing.	Manure and rate per acre.	Irrigation.	Weeding.	Year.	Manure and rate per acre.	Crop.	Actual.	Per acre.		
									M. s.	M. s.	Rs. a. p.	Rs. a. p.
Reana luxurians,	200	English ploughed July 12th	Dung 190 mds.	Once, Aug. 21	Once, July 25th	1877-78 1878-79 1879-80	Sweepings 200 mds. *Nil* *Nil*	Wheat Barley Cotton	3 20	84 28	27 7 0	28 3 8
Juar (Holcus sorghum).	200	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	42 25	305 21	27 7 0	101 13 5
Sorgho (Sorghum saccharatum, red seeded variety).	200	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	11 35	287 15	27 7 0	95 12 8
Ditto, black seeded variety.	200	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	15 20	375 4	27 7 0	125 0 6
Guinea grass (Panicum Jumentorum).	128	Ditto	Dung in Apr. 1879; none since.	Twice; in May, 1880, and Sept, 1880.	*Nil*	1878-79 1879-80	Dung *Nil*	Guinea grass planted out. Guinea grass cut once on March, 1880.	15 0	363 0	32 5 0	121 0 0

Taking the *juar* as the standard of comparison :—

Reana luxurians gave an outturn less by 73 per cent.
Sorgho (red seeded) „ „ „ by 6 „
while Sorgho (black seeded) gave an outturn more by 23 „
Guinea grass „ „ „ by 19 „

Mere *quantity* of outturn no conclusive test, but its *quality* as cattle food must be taken into consideration.

Of course it is impossible to make a strictly fair comparison of these five fodders without taking into consideration their relative values as cattle food, that is to say, their relative nutritiousness. One factor in determining this is the quantity of *water* they contain, and some conclusion may be drawn on this point from the following figures, which show the loss by evaporation which a bundle of each kind underwent when exposed to the air in an open shed for 44 days.

Proportion of uncombined water which each kind contained, as shown by its loss of weight from evaporation.

The original (*i. e.* green) weight of each bundle was 2 maunds (=160 lbs.).

Name of fodder.	*Result of 44 days' exposure to the wind.*			Remarks.
	Weight of bundle as reduced by evaporation.	Percentage of original weight lost by evaporation.	Percentage of original weight remaining.	
	lbs.			
Reana luxurians	*24·	85	15	
Juar	52	67	33	
Sorgho (red seeded)	37	76	24	
Sorgho (black seeded)	38	76	24	
Guinea grass	34·5	78	22	

Altering the weights of green outturn in accordance with those percentages, the following weights of dry fodder are arrived at :—

	Mds.	Seers.
Reana luxurians ...	12	28
Juar ...	100	8
Sorgho (red seeded) ...	68	9
Sorgho (black seeded) ...	90	0
Guinea grass ...	79	8

Judging therefore by the *weight of the outturn*, Reana is shown to be infinitely inferior to the ordinary *chari* of the country, and the produce of a two-acre field in another portion of the farm (also sown with Reana) bears out this conclusion. Of the two varieties of sorgho the black seeded one appears to be the best, and on the experimental plots gave a considerably larger outturn than juar did, while the reverse was the case with the red seeded variety. But both red and black sorgho were cultivated on a large scale during the season under report as well as on these experimental plots, and the result appears to show that, *so far as the weight of outturn is concerned*, juar is but very little, if any, inferior to black sorgho. There appears to be an impression that sorgho has the advantage of *juar* in so far as it will yield two or three successive cuttings from the same plants while juar will only yield one cutting. In order to test the truth of this, I had all four experimental plots irrigated immediately after the crop was cut (on September 11th) and a second cutting made in the middle of November. This second cutting yielded *in green fodder*—

Result of a second cutting of juar, reana, and sorgho.

	Mds.	Srs.		Mds.	Srs.
Reana	1	12	= per acre	31	18
Sorgho, black seeded	3	22	= „	87	4
Sorgho, red seeded	3	2	= „	73	32
Juar	3	0	= „	72	24

Juar is therefore shown to yield a second cutting which is but little less than that yielded by sorgho.

* The great loss in weight which the Reana suffered is due in great measure to its having made less progress than the other crops so that its stems were younger in comparison and therefore more watery.

While therefore the total yield of black seeded sorgho is rather heavier than that of juar the yield of red seeded sorgho is rather lighter, and the advantage on the side of sorgho is practically confined to the superior nutritiousness of its stems.

The advantages which Guinea grass offers.

12. Guinea grass gave an outturn which was a little larger than that of juar, but independently of this it appears in many respects to be a crop eminently suited to meet some of the requirements of Indian farming. In the first place it is a perennial, so that when once planted out the only expense it entails in order to yield two good cuttings a year is an occasional dressing of manure and occasional irrigation. The crop from which the experimental cutting was made had been cut previously in the March preceding, but no manure had been given it since July 1879. It was also very scantily irrigated, the only waterings being one in May, (after the first cutting) and one ten days before the experimental cutting was made. That is to say, the crop kept green during the hot months from April to July with only one watering, and was but little affected by the failure of rain in July and August. It may be safely said that no other fodder crop now known in India could have done this, nor in all probability could the Guinea grass in *its first year*. But in the second year its roots naturally become far stronger and larger than the roots of any annual grass can ever be, and are therefore able to seek the moisture they require at a greater depth in the ground. Hence Guinea grass in its second year may be considered a deep feeding fodder crop; the only one now known in India, and as such it is more able to resist drought than any other of the fodders cultivated. It appears especially well suited for planting along the banks of canal distributaries, streams or ponds, where its roots will be able to obtain moisture for themselves without requiring surface irrigation. It may be mentioned that, on account of those advantages, Mr. Buck made several attempts to obtain a consignment of seed from Messrs. Suttons and other seedsmen, but failed, since it does not appear to be recognised in England by the name it bears in India, and there seems to be a like confusion as regards its scientific name. A consignment has however now been promised, and a certain quantity of seed has been raised on the farm for distribution during the ensuing year.

(iv.) Different kinds of cotton.

13. (iv.) **Different kinds of cotton.**—A careful comparative trial was made of the following varieties of cotton—

The kinds experimented with.

Indigenous cotton,	(*a.*) from Kulpahar in Bundelkhand.
	(*b.*) the kind known as *narma* or *menua*.
Foreign cotton,	(*a.*) the Egyptian variety known as *bamieh*.
	(*b.*) New Orleans.
	(*c.*) Upland Georgian.
	(*d.*) Tree cotton.

Since very little seed of the last four varieties was obtainable, the plots were of but small size, each containing only 100 square yards. The land had borne a wheat crop in the preceding rabi and was manured (for the cottons) with bone superphosphate at the rate of three maunds to the acre.

The field was chosen from its excellent position, since it lay high, and there would have been no chance of the crop being ruined by flooding, as was the case in the year preceding. But it was unfortunate that the cottons should have followed immediately on a crop of wheat, by which the soil must have been much exhausted, and the bone superphosphate which was applied to counterbalance this disadvantage does not seem to have exercised any appreciable effect; still, since all the plots were treated exactly alike, the outturns are a good indication of the *relative* productiveness of the varieties of cotton grown, though not of the *absolute* productiveness of any one of them when cultivated under the best possible circumstances. The results are shown in the subjoined table;—

Name of cotton.	Area of plot in square yards.	Treatment on account of crop experimented with.				Previous treatment.			Outturn of cleaned cotton in lbs.		Cost of cultivation per acre.	Value of outturn per acre.
		Ploughing.	Manure and rate per acre.	Irrigation.	Weeding.	Year.	Manure and rate per acre.	Crop.	Actual.	Per acre.		
Indigenous.											Rs. a. p.	£ s. d.
Kulpahar ...	100	Deep ploughed.	Bone superphosphate @ 3 maunds.	Twice ...	Twice ...	1877-78	Dung 150 maunds.	Maize ...	7·0	338·8	24 9 3	7 15 3½
						1878-79,	Nil ...	Wheat ...				
						1879-80,	Bone superphosphate 2 maunds.	Ditto ...				
Mœnua ...	100	Ditto ...	Ditto ...	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	Nil ...	Nil	...	...
Foreign.												
Bamieh (acclimatized at Saháranpur).	100	Ditto ...	Ditto ...	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	0·8	38·7	24 9 3	1 4 6½
Bamieh (acclimatized at Cawnpore).	100	Ditto ...	Ditto ...	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	3·6	174·2	24 9 3	4 5 2½
New Orleans (acclimatized).	100	Ditto ...	Ditto ...	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	3·9	188·7	24 9 3	5 6 1½
Upland Georgian (acclimatized).	100	Ditto ...	Ditto ...	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	4·3	208·1	24 9 3	5 5 5½
Tree (acclimatized).	100	Ditto ...	Ditto ...	Ditto ...	Ditto ...	1879-80,	Ditto ...	Ditto ...	4·6	222·6	24 9 3	5 15 11½

The values in the last column are calculated from the prices quoted by a Calcutta firm to which a sample of each kind was submitted for opinion, and not, as in all preceding statements, from the prices ruling in the Cawnpore market. They are therefore only of service in showing the *relative* profit yielded by each variety, for in order to show the *actual* profit the cost of carriage to Calcutta must be added to the cost of cultivation.

So far as the *quantity* of outturn is concerned the indigenous Kulpahar cotton shows by far the best, but owing to the character of the season the trial was not altogether a fair one. It is well known that the cotton indigenous to these provinces prefers a year of scanty to one of excessive rainfall, and its cultivation is restricted to the drier portions of the provinces, being almost unknown in the damper districts of Oudh and the Benares Division. The foreign cottons experimented with on the other hand have their homes in far moister climates than that of Upper India, and the failure of rain during the season under report affected them very injuriously, while it was scarcely if at all prejudicial to the *Kulpahar* and other indigenous varieties when grown on well ploughed land. The difference in foliage between the indigenous and imported varieties gives a good clue to the different conditions they require, the leaves of the Egyptian and American cottons being much larger and more succulent than those of the cottons cultivated in Upper India and less fitted therefore for exposure to evaporation. From this reason it is doubtful whether these varieties can ever be grown with more profit

than the indigenous cotton in the districts where the latter is now much cultivated, and the advantage in introducing them would be more in supplying a suitable cotton plant to these districts where the indigenous cotton is not grown, than in substituting a better class of cotton for the indigenous variety in the tracts where it is now largely cultivated, and for which probably it is better suited than any imported variety which has as yet been tried. There is at the present time a variety of cotton grown in Upper India (known as *manua* or *narma*) which somewhat resembles Egyptian and American cottons in the character of its foliage and habit of growth, but its cultivation is restricted to the Eastern districts, those districts in fact in which the ordinary cotton (*kapás*) is least grown. It is not, however, a profitable crop, because its staple lacks strength, though resembling that of American and Egyptian cotton in length and silkiness and also because the plant yields no crop till a year after being sown. This variety was one of those experimented with during the season under report, but yielded no cotton whatever, its season not being till April and May. It is probable that some kinds of American cotton would succeed well in the localities where this *manua* cotton is now cultivated, and thus enable cotton to be grown profitably in those parts of the provinces where it is now almost an unknown crop.

The relative quality of the different cotton grown.

14. Samples of the different varieties of cotton were submitted to a Calcutta firm through the Calcutta Agri-Horticultural Society for opinion as to their relative merits.

The following was the result, the cottons being shown in the order of their merits:—

Name.	*Class.*	*Value per lb.*
Bamieh (acclimatized at Saháranpur).	"Good fair brown Egyptian" staple long, strong and fine.	7¼*d.*
Upland Georgian ...	"Good middling uplands" staple long, but irregular.	6$\frac{15}{16}$*d.*
New Orleans ...	"Middling Orleans," staple short, but strong ...	6¾*d.*
Tree	"Good middling white Egyptian," staple irregular,	6½*d.*
Bamieh (acclimatized at Cawnpore).	"Middling white Egyptian," staple poor, color very good.	5¾*d.*
Kulpahar	"Good Bengal" staple short, but strong ...	5¼*d.*

Taking into consideration quantity of outturn as well as quality, the two most successful of the imported varieties were the *Upland Georgian* and the *New Orleans*, and efforts will be made to import a sufficient quantity of seed to give them trial on a large scale during the ensuing kharíf.

(v.)—Different kinds of maize.

15. **(v.) Different varieties of maize.**—Five varieties of American maize had been imported by Mr. Buck in September, 1879, and a sample of each was sown during the *kharíf* under report, the remainder having been distributed to Court of Wards' estates and the zemindars who are in communication with this department. Unfortunately the seed was bad, and although it was sown four times as thickly as ordinary country maize, the crops were extremely thin. Indeed, in the case of three out of the five varieties only a few seeds germinated, yielding some sickly plants which died before seeding. The other two varieties known as "White flint" and "Tuscarora corn" promised rather better at the outset, but the cobs which they produced contained only a few mishapen seeds, and the outturn was ridiculously small. The failure of rain which spoilt most of the country maize crops on the farm probably accounts in great measure for this; but I am of opinion that it is as cold-weather and not as rain crops that American maizes would succeed in the plains, if they succeed at all. A sample from this very consignment was cultivated at the Lucknow Horticultural Gardens during the cold weather of 1879, and gave promising results. It would obviously be of great benefit to the poorer classes could a maize be introduced which would flourish during the cold weather and yield a crop of food two months before the *rabi* harvesting commenced, and a series of experiments has been initiated on the farm during the present cold-weather season with some seeds of American varieties

Failure of the American varieties tried as kharif crops.

Probability of their success as a cold weather crop

raised in the Katmandu valley of Nepal, which were obtained through the courtesy of Mr. C. E. Girdlestone, the Resident.

II.—The development and manufacture of cheap Agricultural Implements.

B.—The development and manufacture of cheap Agricultural Implements in the Farm Workshops.

16. The implements manufactured during the season under report were ploughs, sieves, winnowers, and pumps.

Ploughs.

Ploughs.—The manufacture of light swing ploughs was continued on a scale sufficient to meet the demand for them. During the six months between June 1st and November 30th 206 ploughs were distributed from the farm workshops, 204 of which were sold (at Rs. 6 a piece) the remaining two being given away as samples. But these figures do not represent the total number of these ploughs manufactured in upper India during the six months, since a large number were made up under the orders of Mr. J. H. Harrison, C.S., and sold to cultivators in the Cawnpore district, and I am informed that others have been manufactured at two places in Tirhut, for the use of indigo planters. The farm is entitled to credit for these, since the pattern on which they were made (known as the "Kaisar") was the one which was modified from American samples and adopted in its workshops.

Sieves.

17. **Sieves.**—The experiments of last *rabi* season having shown the benefit which results from sifting wheat seed before sowing, a number of applications were received for cheap sieves, which could effect the separation of good sized wheat grains from a mixed sample. Wire netting of the requisite mesh was obtained from Calcutta and a three-cornered sieve made up by stretching it on a wooden triangular frame, which could be suspended from a branch or any other support by ropes attached to the corners, and easily worked to and fro by a woman sitting on the ground before it. Thirty-five sieves of this description were sold at Rs. 1-8-0 a piece.

Winnowers.

18. **Winnowers.**—Experiments were continued to determine the form of winnower which would best meet the wants of the Indian cultivator. In the pattern previously adopted the fan was turned by cast iron cog-wheels, which were obtained from Calcutta, casting on a small scale in the workshops having been found not to pay. These cog-wheels were expensive, were easily broken, and could not be repaired; they were therefore discarded and the fan was turned by a strap running on a large wooden wheel attached to the fore part of the winnower. This answers admirably, and the winnower in its present form seems likely to be a marked success, being cheap, light, and easily repairable in case of breakages. Five were sold during the season under report, for use at the coming *rabi* harvest, and ten more have been sold since, the price being Rs. 30 a piece.

Pumps.

19. **Pumps.**—The experiments to determine the best and cheapest form of water-lift were continued under the direction of Mr. W. J. Wilson, C. E. As has been already stated in previous reports, the character of pump fixed upon as being best suited to the country was the modified chain pump, the principle of which had been utilized in the McComas and Bastiat water-lifters. New pumps of this description were made up at Roorkee at a cost of Rs. 120 apiece, but this was beyond the means of an average cultivator. Wooden piping was substituted for metal piping, but was found to leak considerably and to be too bulky and unwieldy: then a hollowed bamboo covered with leather was used instead of the wooden piping, but this, though answering extremely well at first, was found to lack durability. Finally, iron "boiler" piping obtained from Calcutta has been substituted for the bamboo tube, and the rope running in the pipe was fitted with wooden plugs carrying leather suckers instead of the simple knots of hemp used before. These new pipes and plugs answer admirably, and so far as those parts of the pump are concerned the question may be considered satisfactorily settled. But the rope still offered difficulty. Coir rope, which from its durability and inelasticity would, *primâ facie*, appear to be the most suitable kind, was not "bitten" by the groove in the wheel, and slipped round it instead of

being turned by it. Hemp rope, on the other hand, which was "bitten" tightly by the wheel, was too quickly worn out to be suitable. A light chain has now been substituted for the rope and is caught and drawn round by a series of small iron prongs fixed in the groove running round the wheel. This increases the cost of the apparatus by about Rs. 5, but this is more than counterbalanced by the gain in durability.

J. B. FULLER,

Asst. Dir., Dept. Agri. and Commerce,

in charge, Cawnpore Experimental Farm.

No. 581 of 1881.

From

The OFFG. SECRETARY to GOVERNMENT,

North-Western Provinces and Oudh,

To

The DIRECTOR, DEPT., AGRI. and COMMERCE,

North-Western Provinces and Oudh.

Dated Naini Tal, the 13th April, 1881.

Sir,

I am directed to acknowledge your letter No. 622A., dated the 29th March last, with which you submitted the report on the operations at the Experimental Farm, Cawnpore, for the *kharif* season, 1880.

2. Mr. Fuller's report is a very good one, and shows continued progress. His Honor concurs in the remarks in para. 11 of your letter, in regard to the necessity of making some concessions to the prejudices of the people, when this can be done without abandoning the principles which it is the object of these operations to inculcate.

I have the honor to be,

Sir,

Your most obedient servant,

W. R. BARRY,

For *Offg. Secy. to Govt., N.-W. P. and Oudh.*